

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference KN8368-R.WBH	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/EP 98/ 07729	International filing date (day/month/year) 30/11/1998	(Earliest) Priority Date (day/month/year) 28/11/1997
Applicant ASEA BROWN BOVERI AB et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

4

☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No

EP 98/07729

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 H01F27/28 H01F27/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 500 632 A (HALSER III JOSEPH G) 19 March 1996 see figures 4-6	1
A	---	3-5
X	ONDA K ET AL: "THIN TYPE DC/DC CONVERTER USING A CORELESS WIRE TRANSFORMER" PROCEEDINGS OF THE ANNUAL POWER ELECTRONICS SPECIALISTS CONFERENCE, TAIPEI, TAIWAN, JUNE 20 - 24, 1994, vol. 2, no. CONF. 25, 20 June 1994, pages 1330-1334, XP000510364 SOCIETY see figure 6B --- -/--	1,2

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

29 March 1999

Date of mailing of the international search report

08/04/1999

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer.

Vanhulle, R

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/EP 98/07729

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 827 600 A (SHIRO SASAKI) 10 February 1960 see page 5, line 49 - page 6, line 17	1
A	---	3-5
X	DE 387 973 C (PÖGE ELEKTRICITÄTS-A.G.) 9 January 1924 see figures 4,5	1,2
A	---	6
A	US 4 109 098 A (OLSSON MATS GUNNAR ET AL) 22 August 1978 see column 3, line 14 - line 60	7-15
A	---	
A	US 3 781 739 A (MEYER L) 25 December 1973 see figures 5-11	21,22
A	---	
A	US 1 781 308 A (TELEFONAKTIEBOLAGET ERICSSON) 11 November 1930	
A	---	
A	FR 847 899 A (LIGNES TELEGRAPHIQUES ET TELEPHONIQUES) 18 October 1939	
A	---	
A	US 1 762 775 A (BELL TELEPHONE) 10 June 1930	
A	---	
A	US 2 462 651 A (GENERAL ELECTRIC) 22 February 1949	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

EP 98/07729

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5500632	A	19-03-1996	NONE	
GB 827600	A		NONE	
DE 387973	C		NONE	
US 4109098	A	22-08-1978	SE 384420 B AR 211382 A AU 7707175 A BE 825068 A BR 7500229 A CA 1038052 A CH 587545 A DE 2501811 A DK 32675 A FI 750213 A,B, FR 2260173 A GB 1493163 A JP 50109479 A NL 7501168 A SE 7401244 A	03-05-1976 15-12-1977 08-07-1976 15-05-1975 04-11-1975 05-09-1978 13-05-1977 14-08-1975 29-09-1975 01-08-1975 29-08-1975 23-11-1977 28-08-1975 04-08-1975 01-08-1975
US 3781739	A	25-12-1973	FR 2223803 A JP 961023 C JP 49129128 A JP 53039566 B	25-10-1974 28-06-1979 11-12-1974 21-10-1978
US 1781308	A	11-11-1930	NONE	
FR 847899	A	18-10-1939	NONE	
US 1762775	A	10-06-1930	NONE	
US 2462651	A	22-02-1949	NONE	

09/554921
284

PATENT COOPERATION TREATY

PCT

2832
16
REC'D 17 MAR 2000

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference KN8368-R.WBH		FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/EP98/07729	International filing date (day/month/year) 30/11/1998	Priority date (day/month/year) 28/11/1997	
International Patent Classification (IPC) or national classification and IPC H01F27/28			
Applicant ABB AB et al.			

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 5 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 11/06/1999	Date of completion of this report 15.03.00
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Van den Berg, G Telephone No. +49 89 2399 2499 

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/EP98/07729

I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.)*:

Description, pages:

1,3,5-9	as originally filed			
2,4	as received on	03/12/1999	with letter of	02/12/1999

Claims, No.:

1-13	as originally filed			
14-21	as received on	03/12/1999	with letter of	02/12/1999

Drawings, sheets:

1/3-3/3	as originally filed
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2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/EP98/07729

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1 - 21
	No:	Claims	none
Inventive step (IS)	Yes:	Claims	1 - 21
	No:	Claims	none
Industrial applicability (IA)	Yes:	Claims	1 - 21
	No:	Claims	none

2. Citations and explanations

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/EP98/07729

To point V:

1. (Novelty)

None of the documents cited in the international search report anticipates a power transformer as claimed in claim 1 and a method of winding a power transformer as claimed in claim 20. Therefore, the subject-matter of claims 1 - 20 meets the requirement of Article 33(2) PCT.

2. (Inventive step)

Proceedings of the Annual Power Electronics Specialists Conference, Taipei, Taiwan, June 20 - 24 1994, vol. 2, no. CONF. 25, 20 June 1994, pages 1330 - 1334 describes a thin type DC/DC converter using a coreless wire transformer for application to small power supplies. US 5 550 632 A relates to output transformers for use with push-pull vacuum tube audio amplifiers. GB 0 827 600 discloses a wide band audio transformer as well. DE 387 973 describes a further transformer. US 4 109 098 relates to a high voltage cable. US 1 781 308, FR 847 899, US 1 762 775 and US 2 462 651 disclose further transformers from the prior art none of which being directed to a power transformer solving the abovementioned problem nor suggesting the claimed configuration.

None of these documents relates to a power transformer subject to the problem of short circuits. The solution of this problem as claimed in claims 1 and 20 is therefore not obvious from the teaching of any of these documents. Neither would a (purely hypothetical) combination of their teaching result in the transformer and the method claimed in claims 1 and 20, respectively.

As a consequence, the subject-matter of claims 1 and 20 is not rendered obvious by any of the cited documents. Therefore, the subject-matter of claims 1 and 20 meets the requirement of Article 33(3) PCT.

The dependent claims include embodiments of the power transformer and the winding method of claims 1 and 20. The subject-matter of the dependent claims therefore meets the requirement of Article 33(3) PCT as well.

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/EP98/07729

3. (Industrial applicability)

The subject-matter of claims 1 - 21 is conform with the requirement of Article 33(4) PCT.

To point VIII:

(Article 6 PCT)

Claim 1 is not clear in that "each of said windings comprises ..." instead of "each of said windings consist of ...". Furthermore, claim 1 does not define a flexible conductor having electric field containing means surrounding it. Claim 20 does not clearly express "simultaneously winding high voltage and low voltage flexible conductors each conductor having electrical field containing means" (cf. claim 1).

Other types of core structures are, however, known, e.g. so-called shell transformer structures, which normally have rectangular windings and rectangular leg sections disposed outside the windings.

5

Air-cooled conventional power transformers for lower power ranges are known. To render these transformers screen-protected an outer casing is often provided, which also reduces the external magnetic fields from the transformers.

10

Most power transformers are, however, oil-cooled the oil also serving as an insulating medium. An oil-cooled and oil-insulated conventional transformer is enclosed in an outer case which has to fulfil heavy demands. The construction of such a transformer with its associated circuit couplers, breaker elements and bushings is therefore complicated. The use of oil for cooling and insulation also complicates service of the transformer and constitutes an environmental hazard.

20

A so-called "dry" transformer without oil insulation and oil cooling and adapted for rated powers up to 1000 MVA with rated voltages from 3-4 kV and up to very high transmission voltages comprises windings formed from conductors such as shown in Figure 1. The conductor comprises central conductive means composed of a number of non-insulated (and optionally some insulated) wire strands 5. Around the conductive means there is an inner semiconducting casing 6 which is in contact with at least some of the non-insulated strands 5. This semiconducting casing 6 is in turn surrounded by the main insulation of the cable in the form of an extruded solid insulating layer 7. This insulating layer 7 is surrounded by an external semiconducting casing 8. The conductor area of the cable can vary between 80 and 3000 mm² and the external diameter of the cable between 20 and 250 mm. At least two adjacent layers have substantially equal thermal expansion coefficients.

The transformer according to the invention can be a one-, three- or multi-phase transformer and the core can be of any design. Figure 2 shows a three-phase laminated core transformer. The core is of conventional design and
5 comprises three core legs 9, 10, 11 and joining yokes 12, 13.

The windings are concentrically wound around the core legs. In the transformer of Figure 2 there are three
10 concentric winding turns 14, 15, 16. The innermost winding turn 14 can represent the primary winding and the two other winding turns 15, 16 the secondary winding. To make the Figure more clear such details as connections for the windings are left out. Spacing bars 17, 18 are provided at
15 certain locations around the windings. These bars 17, 18 can be made of insulating material to define a certain space between the winding turns 14, 15, 16 for cooling, retention etc. or be made of an electrically conducting material to form a part of a grounding system of the windings 14, 15,
20 16.

The mechanical design of the individual coils of a transformer must be such that they can withstand forces resulting from short circuit currents. As these forces can
25 be very high in a power transformer, the coils must be distributed and proportioned to give a generous margin of error and for that reason the coils cannot be designed so as to optimize performance in normal operation.

30 The main aim of the present invention is to alleviate the above mentioned problems relating to short circuit forces in a dry transformer.

This aim is achieved by a transformer as defined in
35 claim 1.

By manufacturing the transformer windings from a conductor which is magnetically permeable but has practically no electric fields outside an

14. A transformer according to any one of claims 7 to 13, characterised in that each of said three layers is fixedly connected to the adjacent layers along substantially the whole connecting surface.

5 15. A transformer according to any one of claims 7 to 14, characterised in that the cross-section area of the central conductive means is from 80 to 3000 mm².

10 16. A transformer according to any one of the preceding claims, characterised in that the external diameter of the conductor is from 20 to 250 mm.

15 17. A transformer according to any one of the preceding claims, characterised in that struts (27) of laminated magnetic material are located between the windings.

18. A transformer according to any one of the preceding claims, characterised in that the electric field containing means is designed for high voltage, suitably in excess of 10 kV, in particular in excess of 36 kV, and 20 preferably more than 72.5 kV up to very high transmission voltages, such as 400 kV to 800 kV or higher.

19. A transformer according to any one of the preceding claims, characterised in that the electric field containing means is designed for a power range in excess of 25 0.5 MVA, preferably in excess of 30 MVA and up to 1000 MVA.

20. A method of winding a power transformer, comprising simultaneously winding high voltage and low voltage flexible conductors having electric field containing means but which are magnetically permeable, such that turns 30 of the high voltage winding are intermixed with turns of the low voltage winding.

21. A method according to claim 20, characterised in that the high voltage and low voltage conductors are simultaneously unwound from respective drums and wound on to a transformer drum.

PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

To:

NEWBY, Martin, John
J.Y. & G.W. Johnson
Kingsbourne House
229-231 High Holborn
London WC1V 7DP
ROYAUME-UNI

Date of mailing (day/month/year) 03 August 1999 (03.08.99)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference KN8368-R.WBH	
International application No. PCT/EP98/07729	International filing date (day/month/year) 30 November 1998 (30.11.98)

1. The following indications appeared on record concerning:

☒ the applicant ☐ the inventor ☐ the agent ☐ the common representative

Name and Address

ASEA BROWN BOVERI AB
S-721 78 Västerås
Sweden

State of Nationality

SE

State of Residence

SE

Telephone No.

Facsimile No.

Teleprinter No.

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☒ the address ☐ the nationality ☐ the residence

Name and Address

ASEA BROWN BOVERI AB
S-721 83 Västerås
Sweden

State of Nationality

SE

State of Residence

SE

Telephone No.

Facsimile No.

Teleprinter No.

3. Further observations, if necessary:

The postcode has changed.

4. A copy of this notification has been sent to:

<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

S. De Michiel

Telephone No.: (41-22) 338.83.38

PCT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

NEWBY, Martin, John
J.Y. & G.W. Johnson
Kingsbourne House
229-231 High Holborn
London WC1V 7DP
ROYAUME-UNI

Date of mailing (day/month/year) 08 October 1999 (08.10.99)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference KN8368-R.WBH	
International application No. PCT/EP98/07729	International filing date (day/month/year) 30 November 1998 (30.11.98)

1. The following indications appeared on record concerning:

☒ the applicant ☐ the inventor ☐ the agent ☐ the common representative

Name and Address

ASEA BROWN BOVERI AB
S-721 83 Västerås
Sweden

State of Nationality

SE

State of Residence

SE

Telephone No.

Facsimile No.

Teleprinter No.

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☒ the name ☐ the address ☐ the nationality ☐ the residence

Name and Address

ABB AB
S-721 83 Västerås
Sweden

State of Nationality

SE

State of Residence

SE

Telephone No.

Facsimile No.

Teleprinter No.

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

Athina Nickitas-Etienne

Telephone No.: (41-22) 338.83.38

PCT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

United States Patent and Trademark
Office
(Box PCT)
Crystal Plaza 2
Washington, DC 20231
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 22 July 1999 (22.07.99)	Applicant's or agent's file reference KN8368-R.WBH
International application No. PCT/EP98/07729	Priority date (day/month/year) 28 November 1997 (28.11.97)
International filing date (day/month/year) 30 November 1998 (30.11.98)	
Applicant SCHÜTTE, Thorsten et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:

11 June 1999 (11.06.99)

☐ in a notice effecting later election filed with the International Bureau on:2. The election ☒ was☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

<p>The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland</p> <p>Facsimile No.: (41-22) 740.14.35</p>	<p>Authorized officer F. Baechler</p> <p>Telephone No.: (41-22) 338.83.38</p>
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